

The Use of Satellite Technologies in Mapping Flood Extent and Analysis of Its Impact on the Availability of Ambulances in Flood Areas



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Context & Problem

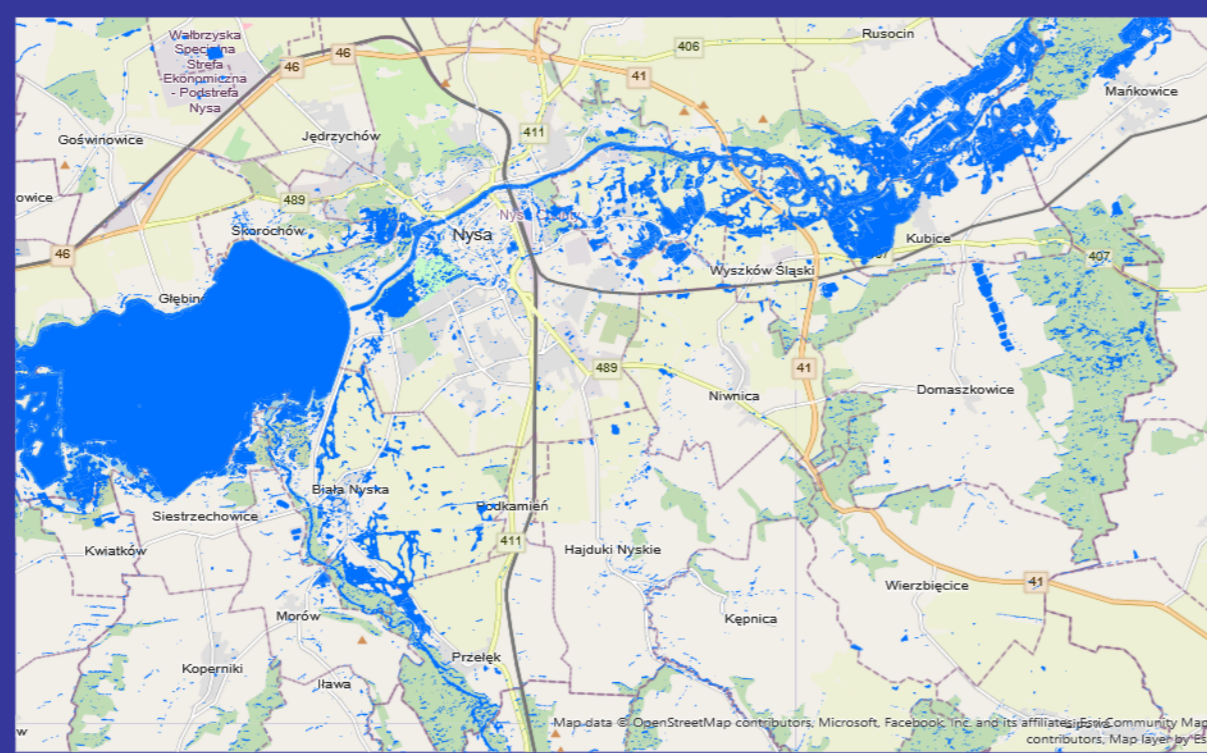
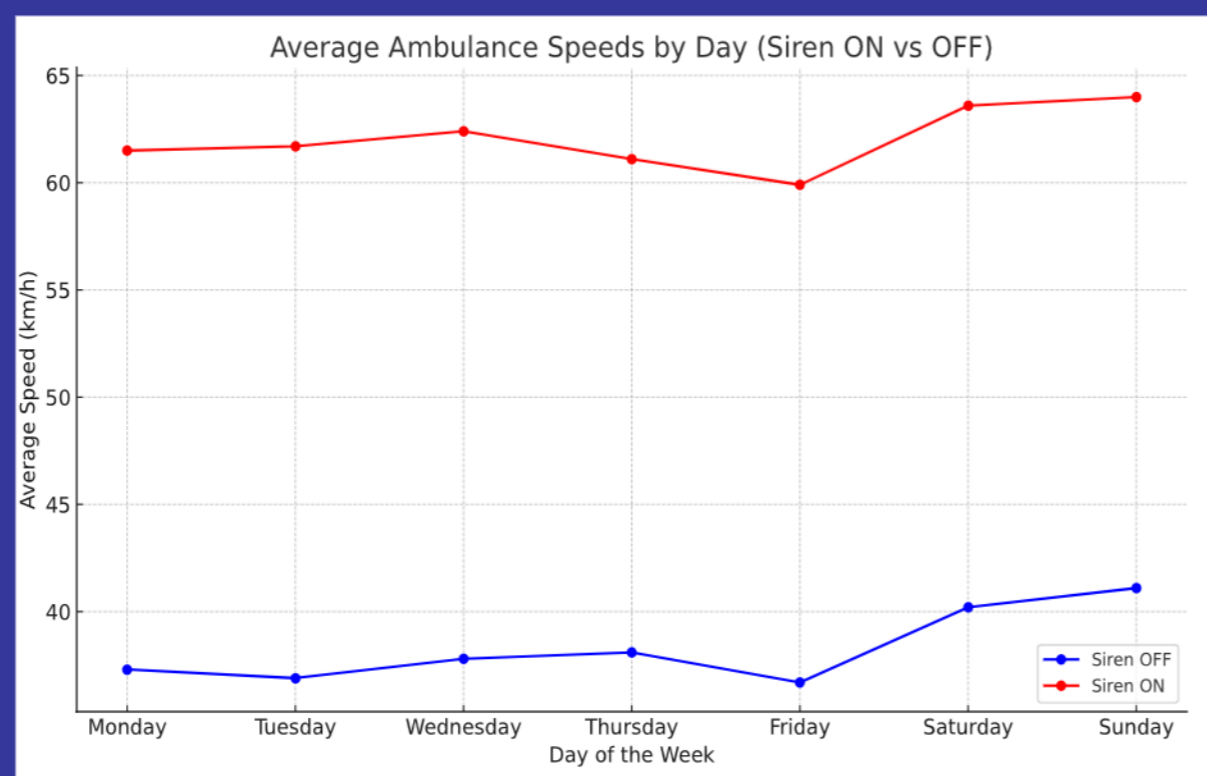
This project analyzes how flooding affects ambulance routes and response times. The case study focuses on Nysa, a city in the Opole Voivodeship, impacted by a major flood in southwestern Poland in September 2024. Due to limited GPS data, available data from the Lesser Poland Voivodeship was used. The hypothesis assumed that average ambulance speeds in Bochnia—a town similar to Nysa in area, road layout, and population—would be comparable. The analysis included estimating ambulance speeds with and without sirens, mapping flood extent using SAR data, and generating buffers to visualize areas ambulances could reach within specific time intervals before and after the flood.



Methods

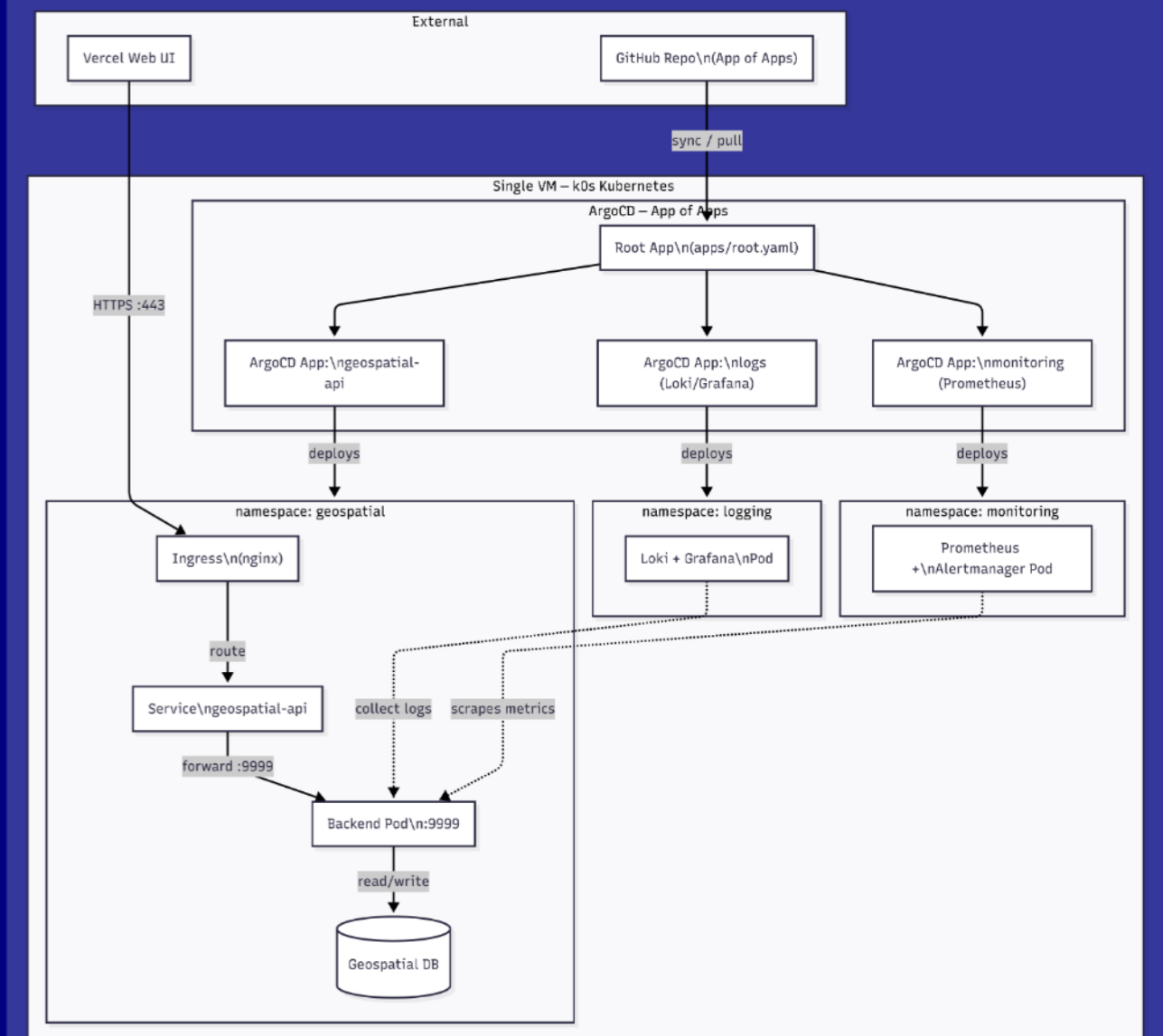
+800 million
GPS logs

The study analyzed GPS data from 1747 ambulances (2020–2023) using PostgreSQL to determine average speeds with and without sirens. By integrating Sentinel-1 SAR and optical data from September 2024, the project mapped flood extents in Google Earth Engine, producing a modified road network that accounts for flood-related obstacles.



Architecture & Deployment

The infrastructure utilizes a k0s Kubernetes cluster managed through a GitOps workflow, ensuring the entire stack stays synchronized with GitHub. The Vercel-hosted frontend communicates with a containerized backend for efficient traffic routing. Data persistence is handled by a dedicated Geospatial Database, while integrated logging and monitoring modules track system health in real-time.



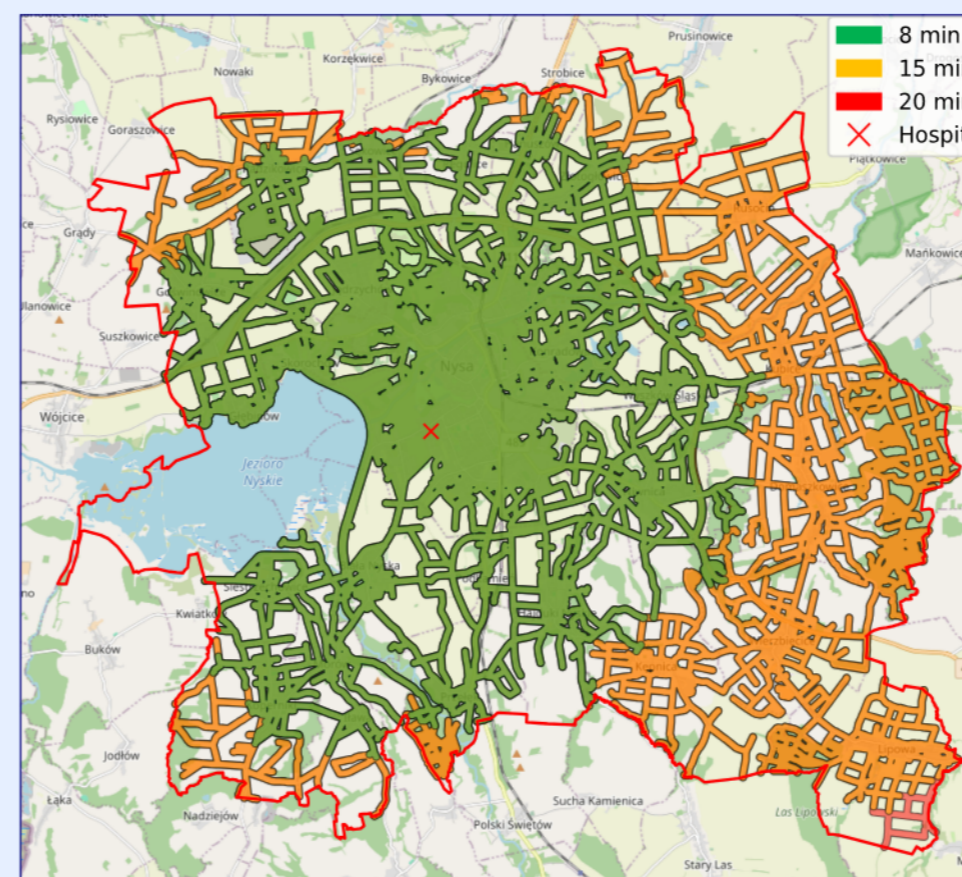
Results

Analysis of the results indicates that the flood affecting the city of Nysa was one of the most serious in recent decades. It caused significant disruptions to mobility, including critical delays for emergency medical services. In certain areas, ambulance accessibility dropped to levels that created a serious risk to human life and health. The most affected regions were located in the southwestern part of the city and along the river, where several communities were effectively cut off from access. To visualize these impacts, a web application was developed to display travel isochrones, shortest paths, flood extent, and barriers, with options to select velocity models based on day of the week and weather conditions.

Potential use of this solution include:

- Automated ambulance fleet management during flood
- Real-time support systems for emergency centers
- Risk analysis for urban planning and infrastructure in flood-prone areas

BEFORE



AFTER

